

Volume 9

Number 5

May 1986

National Academy SCIENCE LETTERS

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Root nodulation in *Acacia holosericea* - An introduced tree species from Australia

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ABSTRACT *Acacia holosericea*, a thornless, non-browsed introduction from Australia is found to be more promising than *Eucalyptus tereticornis* both in stocking and biomass production in the lateritic soils of Pudukkottai regions of Tamil Nadu (pH 5.5 to 6.0). Being a legume, it produces root nodules an advantage over *Eucalyptus* in enriching the soil fertility through nitrogen fixation. An attempt has been made to isolate and characterise the microsymbiont, the nodule bacterium. The results have revealed that *A. holosericea* is nodulated by *Rhizobium* sp. cowpea miscel-lany group.

For successful afforestation of waste lands, particularly in the semi arid and arid lands of Tamil Nadu, the number of available plant species are few like *Eucalyptus tereticornis*, *Acacia planifrons*, *A. nilotica* and *Hardwickia binata*^{1,2}. Newer and fast growing tree species are being sought to meet the growing demand for pulp and fire wood and very recently *Acacia holosericea* A. Cunn. Ex. Don. (Fam. Mimosoideae), a thornless species from Northern Australia, has been under trial in Tamil Nadu. This species has shown fast growth over *Eucalyptus tereticornis* largely grown for pulp wood in semi arid tracts (Table 1). In general, plants belonging to mimosoideae hardly bear nodules³; however, *A. holosericea* nodulates profusely in Tamil Nadu. Also,

the nodulating characteristics of *Acacia pellita* has been reported in Australia⁴. *Acacia holosericea* is the current botanical name for *A. pellita*. It should be admitted that the species of root nodule bacterium has not been reported so far. If the appropriate nodule bacterium is inoculated with the seeds the quantity of atmospheric nitrogen fixation would be greatly improved even in such nitrogen poor soils of the Southern districts of Tamil Nadu. At present it is not known which species of rhizobium produces nodules in this plant. In this communication we are reporting the root nodulation in *A. holosericea* and the species of the microsymbiont.

TABLE 1
Growth characteristics of two species of plantation crop.

Plant species	Age in months	Height (cm)	Diameter at collar (cm)	Stem weight (kg)	Root weight (kg)	Leaf weight (kg)
<i>Acacia holosericea</i>	15	307.3	4.02	1.90	0.522	2.16
<i>Eucalyptus tereticornis</i>	15	211.0	2.93	1.07	0.626	0.149

(Mean of 25 plants)

One year old seedlings of *A. holosericea* established in the typical red loam soils of the Tamil Nadu Agricultural University, Coimbatore and two year old seedlings grown around Auroville. South

Arcot District were examined for natural nodulation. All plants showed nodulation though it was scant. The nodules were small, 2-4 mm long and 0.5 mm wide, elongated and cream and dark brown in colour. The nodules are fascicled in the side branches of the root and not seen at the crown; often the nodules appear far removed from the tap root. The number of nodules per plant ranged from 40 to 120.

The microsymbiont implicated in the nodulation was isolated following the standard procedures used in rhizobiology^{5,6}.

The isolates were maintained on mannitol yeast extract congo red agar medium. The characterization of the isolates was done following standard procedures⁷. The results are presented in Table 2. The cultural and physiological characteristics of the isolates revealed that they are none other than species of *Rhizobium*. On inoculation to the host, *A. holosericea* maintained in seedling agar in test tubes, the plants produced nodules indicating their

identity as *Rhizobium*.

To find out the species status of *Rhizobium* isolates a cross inoculation test was conducted under pot culture conditions using sterile garden loam. Plant species like black gram, (*Vigna mungo*), green gram (*Vigna sinensis*), cowpea (*Vigna unguiculata*), soybean (*Glycine max*) and *A. holosericea* were included. In addition, a guinea pig host and the often described pormiscuous host, siratro (*Macroptilum atropurpureum*) was also included. The cell suspension of the isolates were prepared in yeast extract mannitol broth, grown for 120 h and 5 ml of the broth (containing 10^8 cells/ml) was used for inoculation. Throughout the period of study the pots were irrigated with only sterile rain water. The plants were examined for nodulation after 30 days. The results (Table 3) reveal that all the isolates from *A. holosericea* nodulated black gram, green gram, cowpea and siratro but not on soybean. This suggests that the bacterium *Rhizobium* belongs to the cowpea miscellany group.

TABLE 2
Characteristics of bacterial isolates from the nodules of *Acacia holosericea*

No.	Characters	Isolate 1	Isolate 2	Isolate 3	Isolate 4
1.	Colony appearance on YEM + cango red medium	White to opaque translucent	Opaque and watery	White opaque	Pinkish white, translucent, raised and circular
2.	Cell morphology	Medium sized 0.5-1.0 \times 1.0-2.5 μ M rods, peritrichous flagella	Medium sized 0.5-1.0 \times 1.0-2.0 μ M rods, peritrichous flagella	Medium sized 0.5-1.5 \times 1.0 2.8 μ M peritrichous flagella	Medium sized cells rods, 0.5-1.8 \times 1.5-2.8 μ M, peritrichous flagella
3.	Gram reaction	Negative	Negative	Negative	Negative
4.	Production on YEM medium	Profuse	Profuse	Profuse	Moderate
5.	Growth on peptone broth	Profuse	Moderate	Profuse	Moderate
6.	Hydrogen sulphide production	Nil	Nil	Nil	Nil
7.	Production of ketolactose	Negative	Negative	Negative	Negative
8.	Growth in Hofer's alkaline broth	No growth	No growth	No growth	No growth
9.	Acid production from glucose	Positive	Positive	Positive	Positive
10.	Plant infection test with siratro*	Nodules formed	Nodules formed	Nodules formed	Nodules formed

*Conducted in test tubes with seedling agar

TABLE 3

Nodulation of certain legumes by *Rhizobium* isolates from *Acacia holosericea*

Host plant	Number of nodules per plant			
	Isolate 1	Isolate 2	Isolate 3	Isolate 4
<i>Vigna radiatus</i> (green gram)	8	12	6	4
<i>V. mungo</i> (black gram)	3	6	9	2
<i>V. unguiculata</i> (cowpea)	3	6	14	5
<i>Macroptilium</i> <i>atropurpureum</i> (siratro)	3	4	7	3
<i>Glycine max</i> (soybean)	-	-	-	-

(Mean of three observations)

In order to verify whether cowpea miscellany *Rhizobium* is the nodulating microsymbiont in *A. holosericea* another pot trial was conducted where authenticated cowpea rhizobia from groundnut (A.H. 6), cowpea (A.H. 12) and also from soybean (*Rhizobium japonicum*) were used to inoculate *A. holosericea* and the nodulation observed (Table 4). Excepting *R. japonicum* other strains, A.H. 6 and A.H. 12 produced nodules on *A. holosericea*. This confirmed the identity of *Rhizobium* sp. cowpea miscellany group.

Based on the above observations it is concluded that *A. holosericea* a newly introduced and promising tree species from Australia nodulates naturally under the tropical conditions of Tamil Nadu and the microsymbiont associated with the nodulation belongs to the cowpea group of *Rhizobium*.

TABLE 4

Nodulation in *Acacia holosericea* by selected strains of *Rhizobium*

Rhizobial strain	Source	Number of nodules per plant
A H. 6	Groundnut	4.0
A.H. 9	Groundnut	8.0
A.H. 12	Cowpea	6.0
G.M.B.S.-1	Cowpea	8.0
C.O.S.-1	Soybean	nil

(Mean of three observations)

The authors thank Dr. S. Anthony Raj, Associate Professor of Agricultural Microbiology, Tamil Nadu Agri. University, Coimbatore for courteously supplying the seeds of siratro.

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Efficacy of some indigenous plant extracts in the control of lemon-rot by two pathogenic fungi

(plant extracts/post-harvest disease/toxic fungi)

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ABSTRACT Efficacy of certain indigenous plant extracts in the control of lemon-rot caused by *Colletotrichum gloeosporioides* Penz. and *Botryodiplodia theobromae* Pat. was assayed. Extracts of *E. globulus*, *P. granatum*, *L. innermis* and *D. stramonium* were effective in checking the fruit-rot caused by *C. gloeosporioides* and *B. theobromae*. Pre-inoculation treatments were comparatively more effective.

TABLE 1

Effect of plant extracts on the fruit-rot of lemon (*C. medica* v. *medica*) by two pathogenic fungi.

Name of the plant	Concentration of plant extract (in percentage)	Percentage of rot			
		<i>C. gloeosporioides</i>		<i>B. theobromae</i>	
		Pre-inoculation dip	Post-inoculation dip	Pre-inoculation dip	Post-inoculation dip
<i>Eucalyptus globulus</i>	30	2.39	3.63	3.40	2.40
	50	2.13	1.45	2.21	1.10
	100	1.12	0.47	1.30	0.64
<i>Punica granatum</i>	30	15.57	5.39	1.54	7.93
	50	5.19	2.37	0.62	4.90
	100	0.89	0.97	0.11	2.32
<i>Gossypium herbaceum</i>	30	11.82	4.48	2.65	1.87
	50	1.86	1.78	1.72	0.78
	100	0.83	0.58	1.01	0.50
<i>Lawsonia innermis</i>	30	10.43	7.14	7.17	9.85
	50	2.93	4.27	4.49	8.29
	100	0.26	2.71	2.88	5.97
<i>Datura stramonium</i>	30	13.64	12.20	13.26	13.13
	50	3.12	8.03	10.86	9.45
	100	0.88	2.99	3.78	6.49
Control		12.64	15.35	12.64	15.35

Plant chemicals have required considerable attention as protectants against pathogens. These natural materials not only cost low but are also safe. Bilgrami *et al.*¹ have suggested the use of plant extracts in the control of aflatoxin production by *Aspergillus flavus* in agricultural commodities. In the present investigations extracts of some indigenous plants were tried to control the fruit-rot of lemon caused by *Colletotrichum gloeosporioides* Penz. and *Botryodiplodia theobromae* Pat.

The aqueous extracts of *Eucalyptus globulus* Labill, *Punica granatum* Linn., *Gossypium herbaceum* Linn, *Lawsonia innermis* Linn. and *Datura stramonium* Linn. at three concentrations (30%, 50% and 100%) were screened against *C. gloeosporioides* and *B. theobromae*. Semi ripe healthy fruits inoculated with the pathogens were treated with the above plant extracts both at pre- and post-inoculation stage for 30 min. Subsequently they were incubated

at 27±2°C in humid chamber for 7 days. The magnitude of the fruit-rot was estimated by scraping

off visibly infected part. The loss in weight and percentage of fruit-rot was calculated by the formula :

$$\text{Percentage of rot} = \frac{W - w}{W} \times 100$$

where, W is the weight of the fruit before inoculation and w is the weight of the fruit after infection by the fungus.

An average of 8 fruits was taken to calculate the extent of fruit-rot and the results are presented in Table 1.

Extracts of all the five plants were found to be effective in checking the lemon fruit-rot (Table 1). Extract of *E. globulus* was most effective followed by *G. herbaceum*. The toxicity of these two plant extracts increased with increasing concentration. Extracts of these plants were more effective when the fruits were treated after inoculation. Mishra

and Dixit² have also reported the toxicity of leaf extracts of *Eucalyptus* sp. against *Helminthosporium oryzae*. Extracts of *P. granatum*, *L. innermis* and *D. stramonium* were effective only above 30% concentration. In general, these plant extracts were very useful in checking the fruit-rot. The treatment was not only effective in checking the fruit but also preserved the fruit and its market value.

Thanks are due to Prof. L. L. Narayana, Head, Department of Botany, Kakatiya University, Warangal, for providing facilities.

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Chemical examination of seeds of *Mirabilis jalapa*

(*Mirabilis jalapa*/β-amyrin/β-sitosterol/β-amyrin-α-L-rhamnosyl-O-β-D-glucoside)

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ABSTRACT Reinvestigation of the seeds of *Mirabilis jalapa* have resulted in the isolation of β-sitosterol, β-amyrin, β-sitosterol-D-glucoside and β-amyrin-3-O-α-L-rhamnosyl-O-β-D-glucoside.

The defatted powdered seeds (1 kg) of *Mirabilis jalapa*^{1,2} were extracted exhaustively with 95% alcohol. The alcoholic extract was successively extracted with benzene, chloroform, ethyl acetate, acetone and methyl alcohol.

β-Amyrin: Benzene soluble fraction was chromatographed on SiO₂ column. Elution of column with pet. ether : benzene (1 : 1) yielded β-amyrin, which was confirmed by preparation of derivatives.

β-Sitosterol: Further elution of the column with pet. ether : benzene (1 : 3) furnished β-sitosterol.

The methanol soluble part when chromatographed over silica gel with ethyl acetate and methanol mixture in different proportion gave a compound β-sitosterol-D-glucoside.

β-Amyrin-α-L-rhamnosyl-O-β-D-glucoside: EtOAc : MeOH (2 : 1) fraction, gave β-Amyrin-α-

L-rhamnosyl-O-β-D-glucoside which on hydrolysis gave a genin and sugars identified as D-glucose and L-rhamnose (by CoPC). The genin crystallised from acetone as colourless crystals m. p. 198-99°, C₃₀H₅₀O, M⁺ 426 which gave positive Zimmerman test and was identical as β-amyrin (m. m. p., CoPC, IR). Confirmed by acetate³⁻⁵ (AC₂O/Pyr.) m. p. 238°, benzoate (Ph CoCl/Pyr.) m. p. 228°, identical (m. m. p, TLC & IR) with authentic sample.

Authors wish to thank Director, R. R. L., Jammu for spectral analysis of the samples. One of us (H.M.G) thanks U.G.C., New Delhi, for awarding Teacher Research Fellowship.

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Determination of gold by atomic absorption spectrophotometry in auriferous quartz through bromate oxidation

(gold/atomic absorption spectrophotometry/auriferous quartz)

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ABSTRACT A modified method for the assay of gold in auriferous quartz samples, based on oxidation of Au(I) to Au(III) using KBrO_3 , solvent-extraction of Au(III) from the matrix using methyl isobutyl ketone and subsequent estimation of gold by atomic absorption spectrophotometry, has been described. A comparison of results of this method with those obtained by the fire-assay method has been made.

The extraction of gold from rock-matrix is usually done by first dissolving the material in a mixture of acids followed by its extraction with a suitable organic solvent and analysis for the gold¹. Huffman *et al.*² treated the sample with a sodium cyanide solution to complexate the gold, which was then acidified with hydrobromic acid and bromine water to oxidize Au(I) to Au(III). The bromaurate(III) ion was then extracted quantitatively into methyl isobutyl ketone (MIBK), and the gold concentration was determined by AAS. This method was found well adapted particularly in case of siliceous limestone ores³. Simmons⁴ has further found that ignition of samples, in some cases, brings the gold recovery to acceptable values which, without ignition, would have been low.

The method reported here has incorporated the roasting of the sample at an optimum temperature

ensuring maximum expulsion of free sulphur. The cumbersome operation of cyanidation has been obviated and potassium bromate has been introduced as a more effective oxidant for the oxidation of Au(I) to Au(III).

Atomic Absorption Spectrophotometer (Varian Techtron Model AA575) with a variable tantalum nebulizer was used. The conditions⁵ of operation of the instrument were as follows: wave length - 242.8 nm, slit width - 0.5 nm, lamp current - 5 mA, fuel - acetylene, support - air. A gold hollow cathode lamp was used as the source.

Reagents: (1) Standard gold solution (1000 $\mu\text{g/ml}$): Prepared by dissolving 0.5000 g of gold metal (A.R., Fisher) in 50 ml of aquaregia, evaporating to dryness on a steam bath. The residue was dissolved in 250 ml of HCl (1 : 1) and the volume made upto 500 ml with distilled water. (2) Methyl isobutyl ketone (MIBK): A HCl-saturated solution was prepared by shaking the solvent with 10% HCl solution.

All the reagents used were of B.D.H. A.R. make. The glasswares used were superior quality borosilicate (Corning), and deionized water was used.

Sample preparation: Samples (drill as well as trench samples) obtained from Sonakhan and Raigarh areas of Madhya Pradesh were crushed to

1 mm size and dried overnight at 110°C in aluminium containers. Representative portions (150–250 g) were ground in a disc mill to a grain size of 120 mesh and a true representative sample (20 g) was obtained following the usual procedure⁶ of sampling.

20 g weight of each sample was mixed with 1 g of ammonium nitrate in a Vitreosil dish and heated in a furnace, at $625 \pm 25^\circ\text{C}$ for 30 min. The sample, after cooling was transferred to a conical flask (250 ml). Potassium bromate (0.5 g), conc. hydrochloric acid (20 ml) and conc. nitric acid (5 ml) were added, the flask was swirled and left for overnight. Further quantities of KBrO_3 (0.5 g), conc. HCl (15 ml), and conc. HNO_3 (3 ml) were added to the flask which was then allowed to simmer on a hot plate for 5–6 h., taking care that it did not dry up. It was cooled, mixed with conc. HCl (10 ml) and made upto 200 ml. The supernatant liquid was centrifuged for five min at 6000 rpm. 100 ml aliquot was mixed with saturated MIBK (10 ml) and shaken vigorously for 3 min in a separatory funnel. The solvent layer containing gold was repeatedly washed with 10% HCl (30 ml), till the washing was found to be colourless, transferred to a stoppered test tube, and allowed to stand for 45 min after which it was aspirated into the AAS unit.

Standard solutions of gold containing 1, 2, 5 and 10 ppm were prepared afresh from the stock solution, after treatment with MIBK in the manner described above. These standard solutions were aspirated similarly, and a calibration graph was obtained (Fig. 1). The gold concentration in each sample was determined with the help of the calibration graph. A saturated MIBK was used as a reference-blank in all the measurements. The burner-head, spray chamber and nebulizer were cleaned prior to measurements, by aspirating absolute alcohol, acetone and saturated MIBK in the sequence mentioned. The variable tantalum nebuliser was suitably adjusted before aspirating the solutions for

optimising absorption readings. The solutions were suitably diluted to obtain readings within the calibration range.

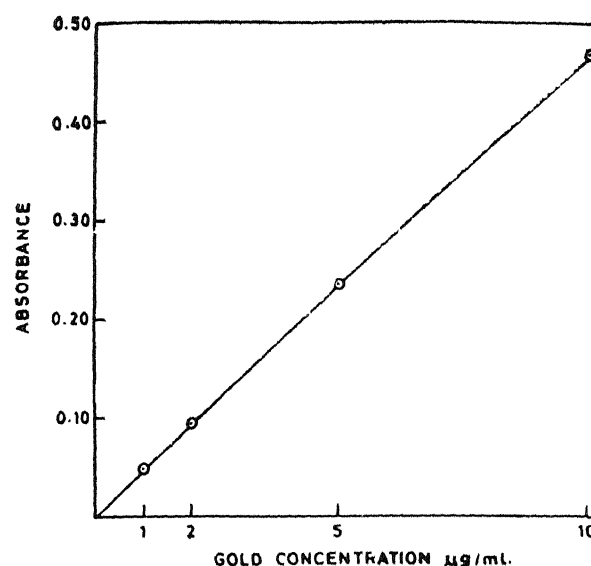


Fig. 1 Calibration graph

Eighteen samples of auriferous quartz were analysed using the procedure described above. The same samples were later analysed by the Bharat Gold Mines Ltd. (Kolar Gold Fields, Karnataka) by the fire-assay method. The results of both the analyses are presented in Table 1. For determining ranges of observed result, nine replicates of analysis of two field samples, and for the % relative error, thirteen replicates of analysis of a Canadian reference ore were carried out. The results are given in Table 2.

The results obtained by applying the present method and those obtained by the conventional fire-assay method, show a good agreement upto 0.1 ppm level of the gold content.

The ranges of observed results (ppm) for 3 samples have been found to be 1.0–1.2 (9 analyses), 1.5–1.8 (9 analyses) and 17.4–18.1 (13 analyses) against the mean values of 1.08, 1.62 and 17.62 respectively. The relative error, at 17.80 ppm level, has been found to be $\pm 2.2\%$.

TABLE 1

Analysis data of gold in auriferous quartz

S. No.	Sample Number	Atomic Absorption method (ppm)	Fire-Assay Method* (ppm)
1	CR/603/6	0.4	0.7
2.	CR/603/10	1.4	1.2
3.	CR/603/16	1.2	1.0
4.	CR/606/11	2.4	2.2
5.	CR/606/12	1.3	1.6
6.	CR/610/9	1.0	1.2
7.	CR/617/20	4.8	4.4
8.	CR/67/5	1.2	1.5
9.	CR/619/2	0.5	0.6
10.	632/7	2.2	2.1
11.	632/9	1.0	1.1
12.	632/31	1.1	1.1
13.	632/32	0.2	0.1
14.	632/37	0.1	0.1
15.	632/38	2.3	2.7
16.	632/42	0.1	0.1
17.	632/47	1.0	1.2
18.	632/48	1.3	1.3

* Analysed by Bharat Gold Mines Ltd., Kolar Gold Fields, Karnataka.

Effect of diverse ions : Although Ag(I), Se(IV), Te(IV), Fe(III), Ti(III), Cr(VI), Mo(VI), As(V), Sb(V), and Sn(IV) have been found to be partially extracted into the MIBK layer these showed no interference in the determination of gold by the above method.

TABLE 2

Ranges of observed results and relative error

Sample	No. of Analyses	Range (ppm)	Mean (ppm)	Recommended value (ppm)	% Relative error
CR/533/20	9	1.0-1.2	1.08	-	-
CR/533/22	9	1.5-1.8	1.62	-	-
MA 1 (Canadian standard)	13	17.4-18.1	17.62	17.80	± 2.2

The method, therefore, can be adapted for the assay of gold in auriferous quartz, and gold monitoring in the locations of this mineral formation.

The authors express their gratefulness to Dr. S. S. Dave, Director, Geology and Mining, Government of M. P., Raipur, for providing facilities.

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Radiation annealing of ^{80}Br retention in nickel bromate

(radiation annealing/kinetics/ ^{80}Br nickel bromate)

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ABSTRACT The initial ^{80}Br retention in neutron activated $\text{Ni}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Ni}(\text{BrO}_3)_2$ are 18.2 and 20.5% respectively. The retention of ^{80}Br following recoil upon radiation treatment is found to be radiation dependent and a partial recovery of the present form could be achieved by radiation treatment in both hydrated and anhydrous forms. The plots of logarithm of the amount to be annealed ($R_p - R_t$) at time t vs. the dose absorbed were practically straight lines indicating that radiation annealing follows first order kinetics. The rate constants computed are 0.037 and 0.077 k min^{-1} for hydrated and anhydrous salts.

Earlier we have reported $\sim 95\%$ retention in several neutron activated bromate systems^{1,2} with the heat treatment. However, the data regarding the effect of radiation treatment on ^{80}Br retention is missing. The present work deals with the radiation annealing in hydrated and anhydrous forms of nickel bromate hexahydrate.

$\text{Ni}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$ was prepared from $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ by heating its solution with $\text{Ba}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$. Then recrystallisation of the salt was carried out. H_2O , BrO_3^- and cation estimations showed the purity of nickel bromate hexahydrate to be $> 98\%$. Anhydrous salt was obtained by heating the salt below the decomposition temperature. Neutron activation was effected at 25°C for 26 min using 13 Ci (nominal)¹²⁴ Sb-Be photoneutron source (flux $10^5 \text{ n cm}^{-2} \text{ s}^{-1}$ and γ -dose 14 rad min^{-1}). For radiation treatment 2 kCi ^{60}Co source (dose rate $5.4 \text{ k rad min}^{-1}$)

was employed. Activity was chemically separated into the bromate and non-bromate parts using solvent extraction method discussed elsewhere³. Activity was measured by a liquid G.M. detector. Corrections were applied for decay, cation activity produced and the density difference between the two solvents used.

Each retention value obtained is reported in percentage and is the average of atleast three independent experiments with a deviation of less than $\pm 1\%$ (absolute). The initial retention values are 18.2 and 20.5% for hydrated and anhydrous form of nickel bromate respectively. In both the cases when the neutron activated samples were exposed to ^{60}Co gammas transfer of recoil radiobromine to bromate occurred. The characteristic trend of recombination yielding a partial recovery of bromate is observed from the retention vs. dose plots (Fig. 1) (dose rate $5.4 \text{ k rad min}^{-1}$). It is seen that recovery is always lower for anhydrous salt than for the hydrated one. Recovery in radiation annealing has been found to be always less than could be possible by thermal annealing. Chemical analysis after radiation treatment did not show any appreciable decomposition of the parent compound.

The plots of logarithm of the amount to be annealed ($R_p - R_t$) at time t vs. the dose absorbed were practically straight lines indicating that radiation annealing follows first order kinetics (Fig. 2). The gamma dose given, the retention at that dose,

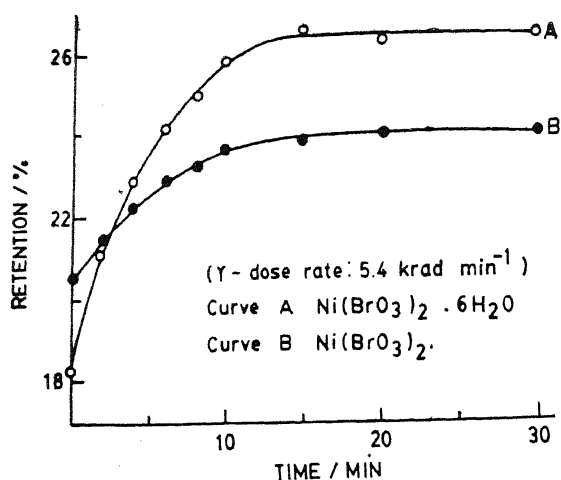


Fig. 1 Retention vs. dose plot

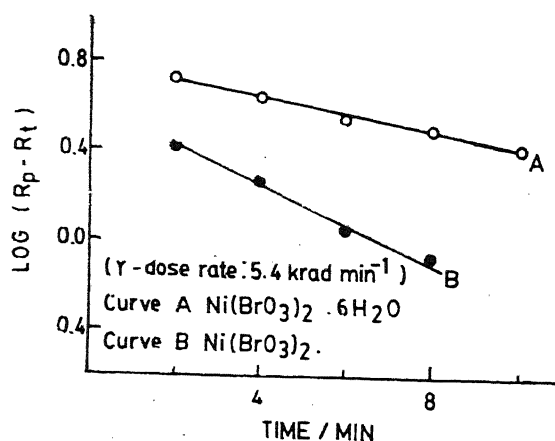


Fig. 2 Plot of $\log (R_p - R_t)$ vs. dose absorbed

$R_p - R_t$ is the difference between the plateau value (R_p) and the retention at time t and the rate constant are presented in Table 1 for $\text{Ni}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Ni}(\text{BrO}_3)_2$. Plateau values were found to be 26.4 and 24.0% for $\text{Ni}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Ni}(\text{BrO}_3)_2$ respectively. The rate constants computed using these plots are 0.037% and 0.077 k min^{-1} respectively for hydrated and anhydrous nickel bromate systems.

Radiation provides energy for recombination of the recoil fragments and apparently the process is

TABLE 1

The difference between the plateau value (R_p) and the retention at time t and the rate constant for $\text{Ni}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Ni}(\text{BrO}_3)_2$.

	Gamma dose given (k rad)	$R_t/\%$	$(R_p - R_t)/\%$	$\log (R_p - R_t)$	Rate constant (k min^{-1})
$\text{Ni}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$	10.8	21.1	5.3	0.7243	
	21.6	22.2	4.2	0.6232	
	32.4	22.9	3.5	0.5441	0.037
	43.2	23.2	3.2	0.5051	
	54.0	23.7	2.7	0.4314	
$\text{Ni}(\text{BrO}_3)_2$	10.8	21.4	2.6	0.4150	
	21.6	22.2	1.8	0.2553	
	32.4	22.9	1.1	0.0414	0.077
	43.2	23.2	0.8	0.9031	
	54.0	23.7	0.3	0.4771	

identical to that of thermal annealing. By way of thermal spikes produced by gammas the recombination process probably continues following simple first order kinetics. It is also believed that radiation annealing is caused by electrons excited from the valance bond. The population of electrons in the conduction band, and consequently the rate of annealing would depend on the density, depth and capture cross section of traps and recombination centres as well as on the forbidden band gap besides the temperature of irradiation.

The author is grateful to Professor M. A. Nabar, Head of the Chemistry Department, University of Bombay and Professor V. K. Phansalkar, Professor of Physical Chemistry, Department of Chemistry, University of Poona, for providing the necessary laboratory facilities. He is also thankful to Dr. V. G. Dedgaonkar, Reader in Nuclear and Radiation Chemistry, Department of Chemistry, University of Poona and Dr. D. N. Patkar, Reader in Inorganic

Chemistry. Department of Chemistry, University of Bombay for the constant encouragement.

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The fractional charges in the quantized Hall effect

(quantized Hall effect/fractional charge)

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ABSTRACT A fractionally charged cloud undergoing an orbital motion and spinning has been found. The vector sum of the spin and the orbital angular momentum leads to fractional charge. All the discovered fractional charges are consistent with the fractions at which plateaus have been observed in the Hall conductance.

Even before the award of the 1985 Prix Nobel to von Klitzing for the discovery of the hitherto unexplained quantization observed in the Hall effect¹, we had become interested² in the explanation of the new phenomenon. We report our finding that there are fractionally charged structures such that the pairwise sum of the charges is an integer multiple of the electron charge. As an observational evidence we rely on the recently reported³⁻¹⁰ plateaus in the quantum Hall conductance. On the basis of gauge invariance, Laughlin¹¹ has shown that at long wave lengths the excitations are fractionally charged.

We consider the electrons in a magnetic field B such that the center of the cyclotron orbit is chosen as (x_0, y_0) . The coordinate y is related to the wave vector as

$$y_0 = \frac{\hbar k}{eB} \quad (1)$$

The centers are separated by

$$\Delta y_0 = \frac{\hbar}{eB} \quad \Delta k = \frac{2\pi \hbar}{L_x B e} \quad (2)$$

where we used the relation $\Delta k = 2\pi/L_x$. The number of center coordinates y_0 within the sample

is called the degeneracy factor for each Landau level given by $N_0 = L_y/\Delta y_0$ in which the substitution of (2) gives

$$N_0 = L_x L_y eB/\hbar.$$

The degeneracy factor per unit area is then

$$N = eB/\hbar \quad (3)$$

and each state occupies an area \hbar/eB as obtained by the commutator $[x_0, y_0] = i\hbar/eB$. The Hall conductivity is given by

$$\sigma_{yx} = \frac{n_s e c}{B} \quad (4)$$

for the surface carrier density of n_s . The Hall voltage V_H and the current I are then determined from the Ohm's law as

$$V_H = \frac{B}{n_s e} I \quad (5)$$

The number of fully occupied levels is ν so that

$$n_s = \nu N = \nu eB/\hbar \quad (6)$$

then the Hall resistivity, $R_H = B/(\nu Ne)$, upon using (3) becomes

$$R_H = \frac{h}{\nu e^2} \quad (7)$$

with $\nu = 1, 2, 3, \dots$. However, now there are two states of the electron, the quasielectron and the quasihole. We define an orbital angular momentum quantum number l and the quantum number s . The Lande g factor for the angular momentum $j = l \pm s$, using the Clebsch-Gordan coefficients is found to be

$$g_{\pm} = (2l + 1 \pm 1)/(2l + 1) \quad (8)$$

so that the modified cyclotron frequency for the n th Landau level becomes $\nu_{\pm}(n)\hbar\omega_c$ where the fractional quantum number is defined by

$$\nu_{\pm}(n) = \frac{1}{2} n g_{\pm} \quad (9)$$

where the signs \pm indicate the spin quantum number. The values of the quantum number for l varying from 0 to 5 and n varying from 0 to 5 are easily generated from (8). We also note that the pairwise sum,

$$\frac{\nu_{+}(n) + \nu_{-}(n)}{n} = 1 \quad (10)$$

reestablishes the integral split in (8). In Table 1 we show the fractional quantum numbers along with their assignments in terms of n , l , and s . All the fractions can be identified with the fractions at

TABLE 1

Filling of the fractionally charged quasi particles in the shell scheme given by n , l and s and thus interpretation of fractional quantum numbers which we found and the reference in which plateaus in the Hall conductance corresponding to that number has been measured. Here n is the Landau level number, l is the new orbital quantum number corresponding to new orbital motion and s is the spin state.

S. No.	ν_{\pm}	n	l	s	Expt Ref.
1	1/3	1	1	-1/2	3
2	2/3	1	1	+1/2	3
3	2/5	1	2	-1/2	5
4	3/5	1	2	+1/2	5
5	3/7	1	3	-1/2	6
6	4/7	1	3	+1/2	6
7	4/9	1	4	-1/2	6
8	5/9	1	4	+1/2	6
9	4/5	2	2	-1/2	5
10	6/5	2	2	+1/2	7
11	4/3	3	4	-1/2	10
12	5/3	3	4	+1/2	10

which plateaus have been measured in the quantum Hall conductance without any exception for which a reference has been included. The pairwise breakup of the fractions is ours. The Table reminds of filling of fractionally charged quasi particles in a shell structure determined by n , l , and s . The new type of shells determine a microstructure of the electron such that the total charge of one shell for a given value of n is a constant. Such a constant is unity for $n=1$. Thus while the number n determines a harmonic oscillator type Landau level, l and s determine the subshells within one value of n . All fractional quantum numbers of our expression are observable. In addition the differences $(\nu_i - \nu_j)\hbar\omega_c$ are also predicted.

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Sulfuric acid-water aerosol particle formation induced by solar radiation

(liquid aerosol/ionization/binary nucleation/ion-ion recombination)

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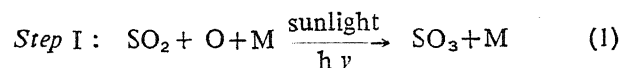
ABSTRACT Previous investigations that $\text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ aerosol particles are formed in polluted moist atmosphere of stratosphere in presence of sunlight, have been applied to the troposphere. The vertical profile for the rate of nucleation of these particles formed around ions created by galactic cosmic rays, has been discussed. It is found that ions enhance the nucleation rate and the effect is maximum at about 7 km.

In the lower atmosphere (troposphere and lower stratosphere) cloud formation takes place through water vapour condensation when supersaturation is about 1% which is much smaller than that required for the homogeneous nucleation. Large supersaturations are prevented by the presence of insoluble and soluble particles, and suspended liquid aerosols. Soluble particles are formed due to chemical reactions taking place in the atmosphere. $\text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ aerosol particles are formed in the atmosphere through heteromolecular homogeneous nucleation phenomenon even when the constituents H_2SO_4 vapour and water vapour are undersaturated¹.

Recently, Hofmann and Rosen² discovered an annual increase in the concentration of cloud condensation nuclei (CCN) at about 30 km and these nuclei were analysed to consist mainly of sulfuric acid molecules³. This increase has been attributed to the fact that in polar cloud chamber H_2SO_4 molecules are formed due to the triggering

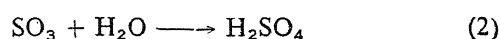
mechanism by ions of solar origin and in the presence of sunlight, in the spring season after long period of dark winter. The newly formed CCN are transported to the mid-latitude areas of atmosphere (e.g. Laramie, Wyoming (USA) 41°N).

Several investigators analysed the rain water and observed that sulphate ion is the major constituent in all the cases, indicating that $\text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ aerosol particles are mainly formed in the atmosphere. The various steps⁴ in chemical reaction of the formation of H_2SO_4 are :



where M is chemically neutral gas molecule (e.g. N_2), oxygen atom having been provided by photodissociation of oxygen molecules.

Step II : (bimolecular collision)



In the presence of water vapour in the humid air $\text{H}_2\text{SO}_4 \cdot n\text{H}_2\text{O}$ embryonic nuclei are formed.

In addition, galactic cosmic rays ionize the lower atmosphere, producing negative and positive ions in equal numbers. Molecules of H_2SO_4 and H_2O form cluster preferably around negative ions. Many workers have studied⁵⁻⁸ the formation of clusters of water molecules in presence of ions. Also, the ions recombine and get neutralized. Thus there is a competition

between the two processes. Considering the competition between H_2SO_4 association and ion recombination at steady state leads to the approximate relationship²

$$J = Q [1 + t_a/t_r] \cdot n_B^* \quad (3)$$

where J is the nucleation rate, Q the ion production

rate, t_a the characteristic time for H_2SO_4 association, t_r the characteristic time for ion-ion recombination, n_B^* the number of H_2SO_4 molecules in a critically sized nucleus.

In troposphere, SO_2 is abundant as pollutant. In presence of water vapours, according to above

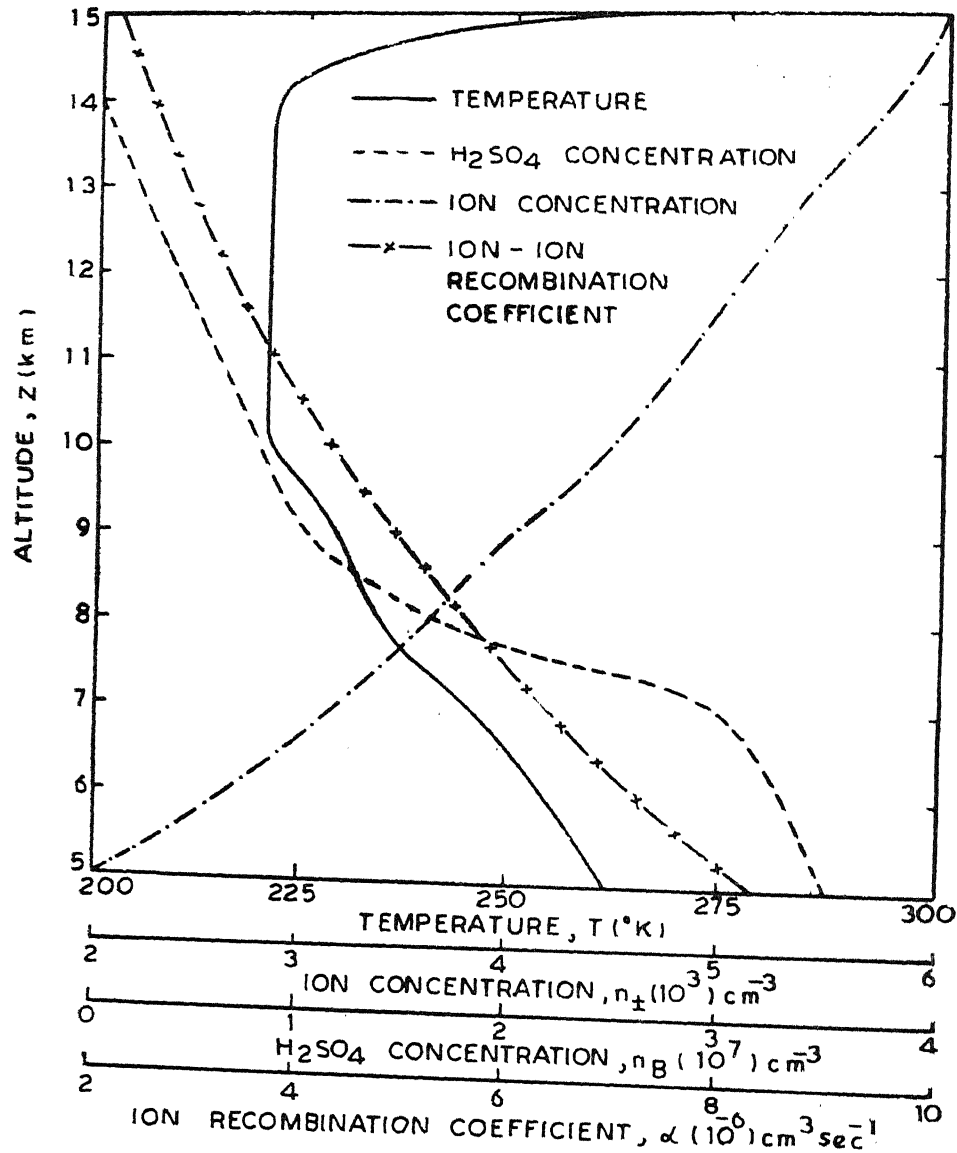


Fig. 1. Vertical profiles of temperature, ion density, H_2SO_4 molecules concentration and ion recombination coefficient above 5 km.

consideration $\text{H}_2\text{SO}_2 - \text{H}_2\text{O}$ aerosol particles are formed in presence of ions. Nucleation in binary systems has been studied⁹⁻¹¹ by other workers.

From the available data for vertical profiles of temperature, H_2SO_4 concentration and ion density, the present treatment can be applied to study the vertical variation of CCN. The H_2SO_4 vapours are generally found in the moist atmosphere with SO_2 abundance, e.g. near active volcanos, industrial estates. Although the present theoretical study is general, it has been applied for the U.S.A. atmosphere for which numerous data for H_2SO_4 vapours are available. Indian continent is free from these vapours as compared to U.S.A. and certain European countries. The rains in India are alkaline or neutral rather than acidic¹².

Using the vertical profiles of temperature, H_2SO_4 concentration¹³, ion density¹⁴ and ion recombination coefficient¹⁵ (Fig. 1), we have estimated the vertical profile for the nucleation rate of $\text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ aerosol particles. The number of H_2SO_4 molecules in a critically sized nucleus is obtained by solving the simultaneous eqns.¹¹

$$\left(\frac{\partial \Delta G}{\partial n_A} (n_A, n_B) \right)_{n_B} = 0 \quad (4)$$

and,

$$\left(\frac{\partial \Delta G}{\partial n_B} (n_A, n_B) \right)_{n_A} = 0 \quad (5)$$

where,

$$\Delta G(n_A, n_B) = n_A (v_A^l - v_A^g) + n_B (v_B^l - v_B^g) + 4\pi r^2 \sigma \quad (6)$$

where n_i is the number of molecules of species i , v_i^l and v_i^g are the chemical potential of species i at liquid phase and gas phase respectively, r the radius of the embryo, σ the microscopic surface tension of the solution. For system $\text{H}_2\text{SO}_4 - \text{H}_2\text{O}$, A and B refer to water and sulfuric acid respectively.

Fig. 2 represents the variation with altitude of the nucleation rates of $\text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ aerosol particles for

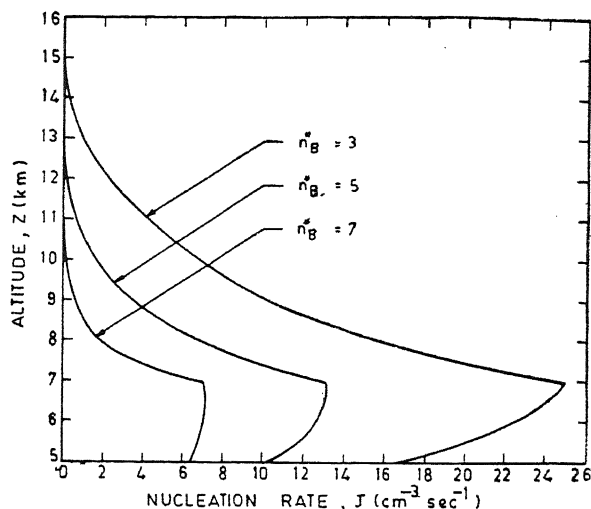


Fig. 2. Variation with altitude of the rate of nucleation of $\text{H}_2\text{SO}_4 - \text{H}_2\text{O}$ aerosol particles with critical nucleus having 3, 5 and 7 molecules of H_2SO_4 .

3, 5 and 7 molecules of H_2SO_4 in a critical nucleus. From the figure it is clear that the nucleation rate increases with altitude, becomes maximum at about 7 km and then decreases rapidly, almost zero at about 15 km. Number of H_2SO_4 molecules in a nucleus depends on the concentration of water vapour and H_2SO_4 . Using the above figure we can estimate the value of the nucleation rate at a given altitude. The computed results have been shown in the Table 1.

TABLE 1

Nucleation rate, characteristic time for H_2SO_4 association and ion-ion recombination at 5 and 10 km altitude for 3 and 5 H_2SO_4 molecules.

Altitude above ground level Z (km)	Ion production rate, Q ($\text{cm}^{-3} \text{s}^{-1}$)	Characteristic time for H_2SO_4 molecule association, τ_a (s)	Characteristic time for ion-ion recombination, τ_r (s)	No. of H_2SO_4 molecules in a critical nucleus, n_B^*	Nucleation rate, J ($\text{cm}^{-3} \text{s}^{-1}$)
5	33.32	15.87	60.02	3	16.48
				5	10.31
10	86.20	69.44	52.20	3	6.81
				5	1.25

From the above results we can conclude that in the lower atmosphere CCN are formed through binary heteromolecular homogeneous nucleation. The ions were found to enhance the mechanism. In the absence of ions, the particles are formed only above certain threshold concentration of H_2SO_4 and water vapour molecules, while in the presence of ions there is no such threshold. Thus, the ions play a dominant role in cloud formation, providing condensation centres through the formation of sulphate aerosols.

One of the authors (N.S.) thanks U.G.C., New Delhi, for financial support.

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Semi-synthetic diets for *Helicoverpa armigera* Hubner

(*Helicoverpa armigera*/semi-synthetic diets/caterpillars)

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ABSTRACT Three potato/french bean based semi-synthetic diets were prepared and their suitability has been evaluated for mass rearing of *Helicoverpa (Heliothis) armigera* Hubner.

Gram pod borer, *Helicoverpa (Heliothis) armigera* Hubner (Lepidoptera: Noctuidae) is a well known polyphagous insect-pest. Besides, red gram (*Cajanus cajan*) and Bengal gram (*Cicer arietinum*), it has been reported feeding on several agricultural, horticultural and ornamental plants¹⁻⁷. Studies on control measures of this pest often require its large laboratory culture for which supply of artificial diet would be a great help. Considering this point in view, suitable artificial diets have been developed for *H. armigera* both in India and abroad⁸⁻¹¹. The present paper deals with three different potato/french bean based semi-synthetic diets for *H. armigera*.

The diets comprised mixture of the following :

- (i) French bean (*Phaseolus vulgaris* L.) 50 g (dry weight), agar-agar 4 g, casein 5 g, brewer's yeast 6 g, methyl parahydroxy benzoate 250 mg, vitamin mixture (Multivitaplex: M/S Pfizer Ltd., Thana, Bombay) 250 mg, ascorbic acid 2 g, 40% formaldehyde 0.5 ml and distilled water 175 ml;
- (ii) dried potato flour 50 g in place of french beans; and

- (iii) dried potato leaf powder 50 g in place of french beans/dried potatoes (tuber) flour.

For preparing (i) french beans were soaked, boiled for few minutes in water and ground with other ingredients except agar-agar, vitamins, ascorbic acid and formaldehyde to a paste in a blender. Later on brewer's yeast, casein and methyl parahydroxy benzoate were blended thoroughly with the said paste. Agar-agar, cooked vitamin mixtures and ascorbic acid were dissolved separately in distilled water. Alongwith formaldehyde, these were finally added to the diet on cooling. In case of (ii) and (iii) diets, dried potatoes flour (50 g) and dried potato leaf powder (50 g) were respectively, added in place of peeled french beans paste. The diets were poured into sterilized glass tubes (15×8 cm) allowed to settle in slanting position at the bottom and used for rearing the caterpillars for about 5-7 days until these did not separate from the sides due to dryness. In case of natural food kept for comparison, the potato leaves were changed daily. 30 newly hatched caterpillars of *H. armigera* were liberated in each glass tube and there were 10 glass tubes for each diet. After the third instar, the caterpillars were separated and reared in isolation for avoiding cannibalism. Pupae thus formed were kept for emergence of the moths. The eggs of these moths were used for next generation.

The data on complete life-cycle of *H. armigera* as shown by shorter larval and pupal periods, higher on three semi-synthetic diets and on its one natural larval and pupal weights, percentage of pupation, food (fresh potato leaves) are presented in Table 1. fecundity and longevity of *H. armigera* reared on

TABLE 1

Development of *H. armigera* on different semi-synthetic diets and potato leaves

Diet	Larval period* (days)	Length of last larval instar (cm)	Weight of last larval instar (mg)	Pupal period* (days)	Pupal weight* (mg)	Pupation (%)	Emergence (%)	Average no. of eggs laid/moth	Viability of eggs (%)	Longevity of moths* (days)
French beans	22.4 ^a	3.1 ^a	506.0 ^a	13.0	354.0 ^a	62.2 (52.06) ^a	96.4 (79.06) ^a	236.0 (15.41)	78.3 (62.24) ^b	10.2 ^a
Potato tuber flour	26.6 ^b	2.6 ^a	376.0 ^b	13.6	313.0 ^a	60.6 (51.12) ^a	90.6 (72.15) ^a	209.0 (14.49)	76.7 (61.14) ^b	10.2 ^a
Potato leaf powder	27.1 ^b	1.6 ^b	189.0 ^c	14.1	264.0 ^b	34.7 (36.09) ^c	53.5 (47.01) ^b	110.0 (10.52)	66.7 (54.76) ^b	6.7 ^b
Fresh potato leaves	29.9 ^c	2.9 ^a	221.0 ^c	13.9	246.0 ^b	47.0 (43.28) ^b	92.5 (74.11) ^a	196.0 (14.03)	97.9 (81.67) ^a	6.5 ^b
S. Em (±)	1.2	0.3	29.0	0.6	20.0	3.4	5.2	1.41	4.5	0.6
C. D. (0.05)	2.5	0.5	59.0	N.S.	40.0	6.9	10.6	N.S.	9.1	1.2

* = Average of 10 replications and two generations; Number followed by the same letters are not significantly different at 0.05 level based on Duncan's multiple range test ('a' is the best followed, respectively by 'b' & 'c'); Figures in parentheses under columns pupation (%), emergence of moths (%) and viability of eggs (%) are 'Angular values' while the figures in parentheses under the column 'Average no. of eggs laid/female' are $\sqrt{x+1}$ values.

The data presented in Table 1 indicate that the insect progeny reared on first two semi-synthetic diets were much healthier than the one reared either on dried potato leaf powder based semi-synthetic diet or on the natural food i.e. fresh potato leaves. Out of the three diets, the one which contained french beans was obviously superior to the other two

this diet.

The authors are highly grateful to Dr B. B. Nagaich, Director, Central Potato Research Institute, Shimla-171 001 (HP), for his encouragement during these studies. Thanks are also due to Shri H. C. Sharma, Scientist S-1 (Statistics) of this Institute for statistical analysis.

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Phosphamidon and lindane induced changes in the hemolymph biochemistry of a penaeid prawn, *Metapenaeus monoceros* (Fabricius)

(phosphamidon/lindane/*Metapenaeus monoceros*)

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ABSTRACT Hemolymph glucose and protein content showed a significant elevation, resulting in hyperglycemia and hyperproteinemia respectively when acutely exposed to lethal concentration ($LC_{50}/48$ h) of phosphamidon (OP) and lindane (OC) pesticides.

The tragic incidence of 'Handigodu syndrome' of Karnataka has been attributed to the long-term consumption of pesticide contaminated crabs and fish by the local population¹. Though much work is done, yet little attention has been made towards the understanding of the effect of pesticides on the hemolymph biochemistry of prawns. This report deals with changes in the glucose and protein levels in the hemolymph of a penaeid prawn when exposed to lethal concentration of phosphamidon (OP) and lindane (OC).

Healthy prawns of 75 ± 5 mm in length, 2.5 ± 0.5 g in weight were collected from Buckingham canal near Thummalapenta seacoast and acclimatized to laboratory conditions for 1 week under constant salinity $15 \pm 1\text{‰}$, pH 7.1 ± 0.1 and temperature $23 \pm 2^\circ\text{C}$. Technical grade phosphamidon (O, O-dimethyl-O-(1-methyl-2-chloro-2-diethyl-carbomoyl-vinyl) phosphate) and lindane (Hexachlorocyclohexane) are used in the present investigation. Prepa-

ration of desired concentrations of phosphamidon and lindane were described elsewhere^{2,3}. LC_{50} value for 48 h was found to be 1.2 ppm and 0.0067 ppm for phosphamidon and lindane respectively. Suitable controls were maintained to know the side effects if any.

Prawns were divided into 3 batches, control and experimental ones were used. The experimental group of prawns was exposed to 1.2 ppm and 0.0067 ppm of phosphamidon and lindane respectively, the other serving as control. The animals were sacrificed at different time intervals 6, 12, 18 and 23 h following the exposure. Hemolymph glucose was estimated using anthrone reagent⁴. The protein content was estimated by using Folin phenol reagent⁵. The data were subjected to statistical analysis⁶.

The data shown in Table 1 reveals the following trends. The hemolymph glucose and protein were shown to be remarkably elevated resulting in hyperglycemia and hyperproteinemia in *M. monoceros* after acutely exposed to lethal concentration of phosphamidon and lindane.

Fingerman *et al.*⁷ found that DDT induced the neurons of the crabs to release the hyperglycemic factor, which resulted in hyperglycemia. It is likely

TABLE 1

Levels of glucose and proteins in hemolymph of control and phosphamidon exposed (PE) and lindane exposed (LE) prawns.

Values are expressed in b=mg/100 ml; c=mg/1 ml.

Each value is mean \pm SD of 6 individual observations.

Parameter	Control	period of exposure (in hours)			
		6	12	18	24
Phosphamidon exposure (PE)					
glucose ^b	50.44	78.41	93.13	106.34	140.39
	± 3.53	± 4.34	± 5.41	± 6.77	± 6.92
		+55.45	+84.64	+110.84	+178.33
Proteins ^c	94.18	105.48 ^a	118.49	138.36	147.49
	± 5.45	± 6.33	± 6.10	± 7.35	± 8.30
		+11.99	+25.81	+46.91	+56.60
Lindane exposure (LE)					
Glucose	52.81	74.36	92.76	115.44	140.42
	± 4.13	± 4.45	±5.64	± 5.78	±7.41
		+40.81	+75.65	+118.59	+165.90
Proteins ^c	91.45	102.33 ^a	124.14	142.41	164.15
	± 5.81	±5.07	±5.39	±10.12	±10.09
		+11.89	+35.79	+55.72	+79.49

All values are significant at $P < 0.001$ except a = $P < 0.01$.

that in the present study both phosphamidon and lindane might be stimulating the neurosecretory cells of *M. monoceros* to discharge or secrete the hyperglycemic principle or hormone like in fashion of the crabs. Hohnke and Scheer⁸ suggested that the possible mode of action of hyperglycemic hormone is to elevate the intracellular glucose through the breakdown of glycogen reserves of the tissues/cells by activating the phosphorylase enzyme complex. The glucose that is present in the intracellular environment will enter into the hemolymph, results in hyperglycemia. Fingerman *et al.*⁷ Bhagyalakshmi *et al.*⁹ and Sreenivasula Reddy *et al.*¹⁰, have also reported similar findings using different crustaceans.

On acute exposure to lethal concentration of phosphamidon and lindane produced hyperprote-

inemia in the hemolymph of *M. monoceros*. Midgut gland being a seat of all metabolic activities, is able to synthesize various protein molecules and which will be entering the hemolymph through the poorly developed circulatory system. In the present investigation hemolymph protein was remarkably elevated causing hyperproteinemia. Further it was earlier reported that pesticide treatment causes the enlargement of hepatopancreas and it may lead to increased protein biosynthesis due to toxic impact of pesticide¹¹. The hepatic hypertrophy induced by several pesticides was also reported¹². The increased protein level, suggestive of increased incorporation of labelled amino acids into the newly synthesizing proteins which after sometime will enter the hemolymph, results in hyperproteinemia¹¹. There were several reports regarding the destruction and disturbance in functional integrity of parenchymatous cells of midgut gland/hepatopancreas and this results in the release of proteins from midgut gland/hepatopancreas to hemolymph thereby the protein level of hemolymph results in hyperproteinemia.

The authors thank U.G.C., New Delhi for financial assistance and to Prof. K. Sasira Babu for encouragement.

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Changes of acid and alkaline phosphatases during the development of the tropical earthworm *Pontoscolex corethrurus*

(acid and alkaline phosphatases/*Pontoscolex corethrurus*)

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ABSTRACT Biochemical studies on acid and alkaline phosphatases were studied in cocoon, young ones and adult stages of *Pontoscolex corethrurus*. The acid and alkaline phosphatases showed four pH optima, two at acidic (pH 3.5 and 5.5) and two at alkaline ranges (pH 9.0 and 10.0). In cocoon and adult stages the acid phosphatases were preponderant over the alkaline phosphatases activity, whereas in young ones alkaline phosphatase was higher than that of acid phosphatase. Effects of substrate concentrations reveal that the K_m values and V_{max} varied with different stages.

Although a number of workers have studied the biochemical changes of phosphatases during the development of invertebrate animals¹⁻⁹, there is a paucity of information on this aspect in earthworms. Hence an attempt has been made to investigate the changes of acid and alkaline phosphatases during the development of the earthworm *Pontoscolex corethrurus*.

To study the acid and alkaline phosphatase activity, the following three morphologically well defined developmental stages were chosen¹⁰.

Cocoon : More or less spherical in shape, opaque and milk white in colour; 3.3 ± 0.4 mm in diameter and 28.3 ± 1.18 mg in weight.

Young ones (Freshly hatched) : It was 1.72 ± 0.18 cm in length; 1.4 ± 0.066 mm in diameter and 13.3 ± 0.87 mg in weight.

Adult : It was about 7.4 ± 1.04 cm in length, 3.2 ± 0.28 mm in diameter and 533.5 ± 39.09 mg in weight.

The developmental stages were separated and washed with glass distilled water. All the stages were homogenized in glass distilled water and 10% homogenate was prepared. The homogenate was centrifuged at 1000 g for 10 min and the clear supernatant was used as enzyme source.

The enzyme activity was determined by the method of Bergmeyer¹¹ as previously described by Balasubramanian *et al.*¹² using p-nitrophenyl phosphate as substrate. The released p-nitrophenol was recorded at 410 nm in a spectrophotometer and the results were expressed as $\mu\text{mole p-nitrophenol liberated mg protein}^{-1} \text{ h}^{-1}$.

To study the effect of pH, various pH levels ranging from 2.0 to 11.0 at an interval of 0.5 veronal acetate buffer were used. The pH solution was adjusted with 0.1 HCl/NaOH solution. Various substrate concentrations ranging from 1 to 32 mM were used to determine the effects of substrate concentration on enzyme activity. Michaelis constant was computed from Line Weaver-Burk plot¹³.

The protein content of the samples was determined by the method of Lowry *et al.*¹⁴ using bovine serum albumin as standard.

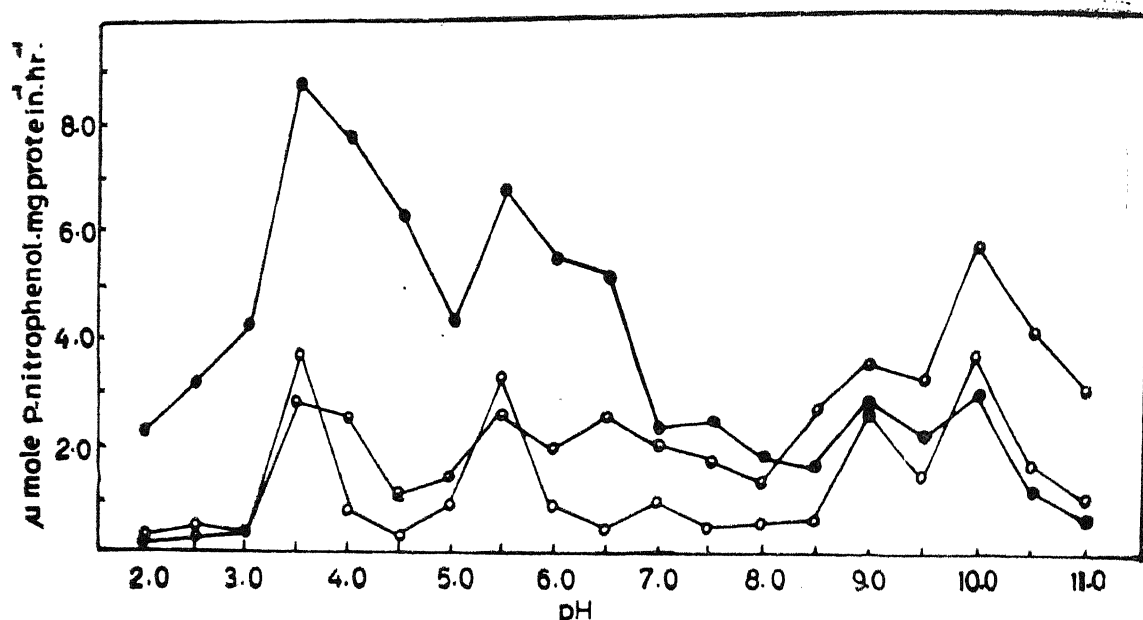


Fig. 1. Effect of pH on acid and alkaline phosphatases in different developmental stages of *Pontascolex corethrurus* ○—○ First Stage, ◐—◐ Second Stage, ●—● Third Stage.

Fig. 1 exhibits that four pH optima, two at acidic (pH 3.5 and 5.5) and two at alkaline range (pH 9.0 and 10.0) in tested stages of *P. corethrurus*. Similar observations were made in other invertebrate groups^{4,9,15,16}. They have also reported the occurrence of more than one pH optima suggesting the presence of more than one enzymes. The present study also reveals more than one pH optima in all the stages of *P. corethrurus*.

Acid phosphatase activity of cocoon and adult was higher than that of alkaline phosphatase, whereas in young ones alkaline phosphatase exhibited high activity. Among the two pH optima in acidic range, the activity at pH 3.5 was higher than that of pH 5.5 (Table 1). High activity in alkaline phosphatases in young ones compared to cocoon and adult may be due to the differentiation and histogenesis of organs and organ systems.

During the development and growth of animals, there is a great fluctuation in enzyme activity¹⁷. In

TABLE I

Relative activity of acid and alkaline phosphatases in different developmental stages of *P. corethrurus*

Stages	Activity μ mole p-nitrophenol mg protein ⁻¹ h ⁻¹	
	Acid phosphatase	Alkaline phosphatase
Egg	3.801 ± 0.01	3.626 ± 0.005
Just hatching	2.971 ± 0.01	5.985 ± 0.002
Adult	8.842 ± 0.01	3.022 ± 0.003

Each value is a mean (S. D.) of three individual observations ± indicates the standard deviation

this study, high acid phosphatase activity was observed at adult and alkaline phosphatase activity was high in young ones (Table 1). Acid and alkaline phosphatases were further characterized by determining the K_m values (Michaelis constants) and V_{max} computing them from Line Weaver-Burk plot¹³. The results reveal that the K_m values and V_{max} varied with different developmental stages of *P. corethrurus* (Table 2).

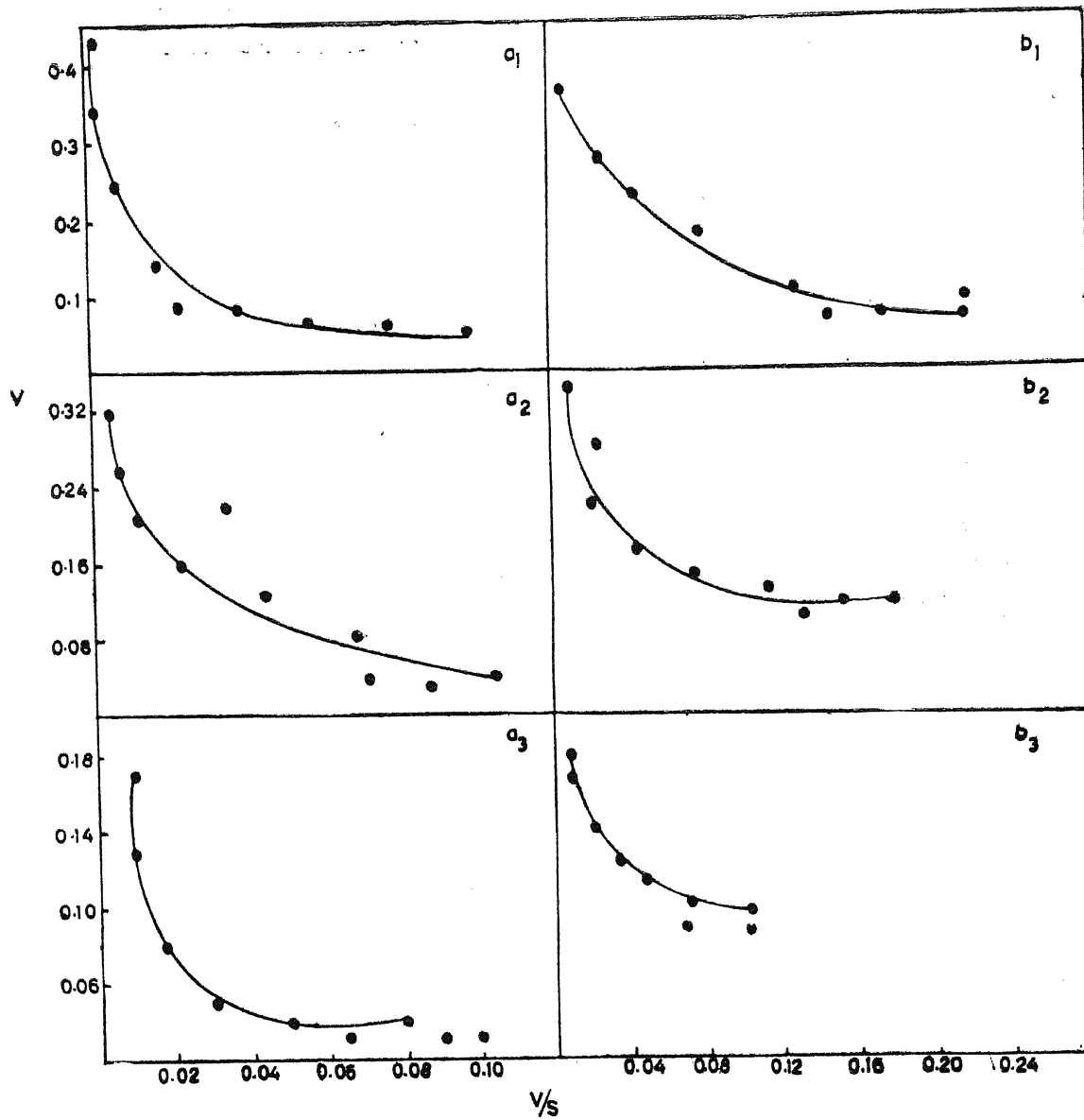


Fig. 2. Effect of substrate concentration on acid and alkaline phosphatases in different developmental stages of *Pontoscolex corethrurus*
a₁, a₂, a₃ - Acid phosphatases (I, II & III stages), b₁, b₂, b₃ - Alkaline phosphatases (I, II & III stages), V is the velocity of enzyme, V/S is the Velocity/Substrate concentration.

TABLE 2

Michaelis constants V_{max} for phosphatases in different developmental stages of *P. corethrurus*

Stages	Km (mM)		Activity (mg PNP/mg protein/h)	
	Acid	Alkaline	Acid	Alkaline
Egg	2.1	2.3	0.0048	0.0056
Just hatching	2.5	3.1	0.0143	0.0167
Adult	6.3	2.6	0.0097	0.0192

To understand whether one or more than one enzyme is involved in the hydrolysis of substrate, the data obtained on velocity was plotted against velocity/substrate concentration. According to Hofstee¹⁸ the nature of the graph obtained should be a straight line in case where one enzyme is involved and should be a hyperbolic curve in case where more than one enzymes are involved. Fig 2- a_1, a_2, a_3 and b_1, b_2 and b_3 which show the activity of acid and alkaline phosphatases of tested stages of *P. corethrurus* are hyperbolic, suggesting that more than one enzymes are involved.

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SCIENCE INFORMATION SERVICE

SOLAR PHOTOVOLTAICS

The Department of Non-Conventional Energy Sources has the responsibility for the development, production and application of solar photovoltaic devices. The direct conversion of solar energy into electricity using photovoltaic systems is considered to have significant potential in India. This route of solar energy utilisation is attractive in view of the favourable solar radiation conditions and large requirement for electrical energy for decentralised applications. The ease of installation and maintenance, lack of noise and pollution, and long life make photovoltaic systems ideally suited for use in remote and isolated areas, forests, hilly and desert regions, etc.

2. During the Sixth Plan which ended in March 1985, the Department implemented a comprehensive programme of R & D, pilot production and demonstration relating to PV technology. The programme led to development of indigenous technology for production, creation of initial infrastructure for the manufacture, installation and maintenance of PV systems and promoted awareness among potential users. These activities have been further diversified and expanded during 1985-86, the first year of the Seventh Plan. The principal objectives of the programme during this plan period are to achieve further cost reductions, expand the scope of utilisation of these devices, achieve technological improvements and promote new technologies. The details of the programme and developments during 1985-86 are outlined below :

Research & Development

3. Widespread use of PV technology requires lowering of costs of solar cells and modules and improving efficiency life and reliability of the systems. With these objectives in view, the DNES has been supporting programme of research and development. A list of R & D projects supported by this department is given at the end of this chapter.

4. Silicon in different forms is the primary material used for solar cell production. Some projects relating to casting and directional solidification of silicon were completed during the year. Questions relating to further upscaling of this effort including the need for establishing pilot production facilities are under examination in consultation with the concerned research groups and industrial organisations.

5. An integrated programme on amorphous silicon solar cells made steady progress. Plasma deposition facilities for experimental work have been established at Indian Association for Cultivation of Science, Calcutta, IIT, Delhi and University of Poona. New equipment has been ordered by the group at National Physical Laboratory. The milestones set for this programme are being achieved on schedule and the progress is being reviewed in periodic meetings of all the research groups. Silane gas, which is an essential input to amorphous silicon production, has been produced in small quantities at IIT, Kharagpur and IISc Bangalore and is being tested for its quality.

6. Amorphous silicon solar cell technology has also been identified as one of the Science and Technology Missions during the Seventh Plan. With a view to accelerate the activity in this area and support the R & D programmes, the DNES proposes to set up a pilot plant for making amorphous silicon solar cells and modules. A preliminary project document has been prepared and forwarded to the UNDP for possible assistance regarding equipment not made within the country. The Department also issued a public notice inviting offers for the supply of equipment for the establishment of the pilot plant. The offers received from different sources are being evaluated.

7. Research on other aspects of PV technology such as photoelectrochemical solar cells, thin film devices based on compound semiconductor materials such as copper indium diselenide, on implantations and laser annealing, systems development, etc. continued to be supported. The department also continued its efforts to promote and evaluate indigenously produced silicon to assess its suitability for PV production. Solar cells and modules made from such materials have been found to be comparable in performance to devices made from imported silicon.

8. The R & D programme also covers testing and evaluation of deepwell pumps and medical refrigerators. Six pumps were imported by the Department and handed over to manufacturing organisations for integration with systems. Six refrigerators have also been received from UNICEF and are similarly being integrated with PV systems. In a separate exercise, the Department is arranging for the import of photovoltaic modules from 7 foreign manufacturers for purpose of evaluation and trial in Indian conditions.

9. In order to carry out a comprehensive review of R & D projects and provide a forum for exchange of views among research groups, a two-day meeting of project investigators was convened by the department in July 1985. The Expert Panel on PV Device

and Systems was also reconstituted during the year.

Nasped Programme

10. A Five-year National Solar Photovoltaic Energy Demonstration (NASPED) programme was sponsored by the Department of Non-Conventional Energy Sources at the Central Electronics Ltd. Sahibabad from October 1980. The main objectives of the programme were the establishment of pilot production facilities for solar cells and modules and the development and demonstration of PV systems for various applications. While demonstration is continuing, the pilot production has led to the establishment of production facilities on commercial lines. The production of solar cells from April to September 1985 under this programme was 126.11 KW. A capacity of 1 MW annual production was however substantially built up. Among the achievements of the programme are :

(1) The technology for solar cells and module production was developed from bench scale to a commercial scale production. A commercial project for upscaling the production to reach in stages a level of 5MW per year has been taken up by CEL based on the technology generated in the NASPED programme. The technology for manufacture of modules has been transferred to Rajasthan Electronics & Instruments Ltd. by CEL.

(2) A variety of systems have been designed, developed and field tested under the programme. These include water pumping systems for drinking water supply and micro irrigation, street lighting units, community lighting systems, community TV, power supplies for off-shore platforms, battery charging, etc.

(3) A number of field level engineers and technicians have been trained in the installation and maintenance of PV systems. The programme also helped create a pool of technical manpower capable of technology development, systems engineering, produc-

tion management and other tasks involved in building up the photovoltaics industry.

(4) A significant measure of awareness was created among different categories of users, particularly State Electricity Boards, State Nodal Agencies for Renewable Energy Programmes, Railways, Telecommunications, Doordarshan, etc.

11. A total of 401 systems were supplied under the NASPED programme between April and September 1985. This included 246 pole mounted street lighting units, 47 water pumping systems and 101 TV systems. Further details are given in the next section.

Demonstration Programme

12. The need for continuing the countrywide programme of demonstration covering PV systems for various applications was emphasised at the start of the Seventh Plan. Accordingly the programme was expanded during 1985-86. The production and other facilities at CEL established under NASPED continued to be utilised for these activities after the ending of the NASPED programme. BHEL, Bangalore, REIL Jaipur and AP Electronics Development Corporation, Hyderabad also participated in this programme through supply of systems. The following are the highlights of the demonstration activities during 1985-86:

(1) **Village Electrification** : A programme for installation of solar powered street lights in 250 villages was taken up during 1984-85 through the Rural Electrification Corporation, State Electricity Boards, and Nodal Agencies of some of the State Governments. About 100 villages, were covered up to March 1985. Installation in a further 60 villages was completed and supplies made for an additional 25 villages between April and December 1985. This includes 17 villages in Andaman & Nicobar Islands. Sanction was also accorded for the electrification of 24 villages and 4 hamlets in Tamilnadu. A programme for the supply of an additional 2000

street lighting units is currently under implementation.

(2) **Centralised PV Systems**: Some of the villages mentioned above are being provided with small "centralised" PV power systems to meet lighting and other electrical energy requirements. An experimental programme in respect of four villages is also being taken up in cooperation with REC. The Department also proposes to set up 4 PV power stations in the range of 10-20 KW. Sites for these stations have been identified and the projects are being evaluated for sanction.

(3) **Water Pumping Systems**: Thirty water pumping systems were supplied to individual farmers between April and December 1985. This completes the supply of 100 pumps under a special project initiated under the NASPED programme. This project covered six States. In addition, 46 systems were supplied to various State agencies for demonstration purposes and other applications. The programme of demonstration and field trial is being further expanded in 1985-86 and arrangements are being made for the supply of 300 pumping systems.

(4) **Community TV Sets**: A total of 200 PV powered direct reception sets are being installed by Doordarshan in U.P. and Bihar. The PV power packs for these systems have been supplied with the support and sponsorship of DNES. These systems enable uninterrupted viewing of TV broadcasts received directly from INSAT-IB.

The Department arranged a Workshop of various State Electricity Boards, State Nodal Agencies for renewable energy programmes, academic and research institutions on 24th and 25th January 1986 in order to review the performance of systems in various locations. Presentations were made by these organisations on the technical performance as well as on problems connected with installation and maintenance of street lighting units, PV pumps and other systems. The Workshop was also attended by representatives of

manufacturing organisations. The Workshop enabled a valuable exchange of experience and indicated points for further action relating to system design and reliability. Among the points that emerged were the need to maintain spares of components and subsystems, increasing the range and capacity of water pumping systems, development of appropriate methodology for field evaluation of water pumping systems and the need for a comparative study between centralised and stand alone street lighting systems. The meeting was also attended by officers from Railways, Defence Services, Border Security Force and other organisations.

Industrial Production

13. DNES is responsible for regulating the industrial and import licensing of solar photovoltaic devices. A number of applications have been received by Government for licensing and registration. These were processed in association with the DGTD and the Secretariat for Industrial Approvals. A total of 15 letters of intent or registrations were issued between April and December 1985. One application for foreign collaboration was approved and two letters of intent issued previously were extended.

14. A meeting of PV manufacturers was held in May 1985. Issues concerning raw material availability, customs and excise duties, were discussed at the meeting. A proforma for collecting information concerning production on a periodic basis was evolved by the Department and circulated to manufacturers.

15. During the year, CEL installed new equipment for production of modules and cells and is expected to achieve a total cell production capacity of 2MW and module production capacity of 1.35MW by March 1986. Lamination technology has been introduced into production. The production at CEL between April and December 1985 amounted to 243KW. The production at BHEL during the same period was approximately 70KWp. A third public sector enterprise, Rajasthan Electronics & Instruments Ltd., also commenced production during the year. New equipment for module making is expected to be installed shortly at this unit.

16. Both CEL and BHEL continued to make supplies of photovoltaic systems for specialised applications such as telemetry power supplies for off-shore oil platforms and communications. The break-up of various systems supplied by CEL and BHEL during 1985-86 (up to 31.1.1986) is given below ;

<i>System</i>	<i>CEL</i>	<i>BHEL</i>
water pumping Systems	69	35
TV and TV-cum-Lighting Systems	212	1
Community Lighting Systems	7	—
Street Lighting Units	637	338
Systems for Off-shore		
Oil Platforms	—	6
Modules for battery		
charging units	300	300
Other Systems	27	1

A BHEL-made PV system for battery charging has been used successfully by the Indian Expedition to Antarctica in 1985-86.

17. The Department also organised a meeting of indigenous silicon manufacturers and PV device manufacturers to assess the requirements of the photovoltaic industry and to see the extent to which domestic manufacturers of polysilicon, silicon ingots and wafers could meet these requirements. The meeting reviewed the existing capacities available, extent of utilisation, quality and cost aspects, etc. Appropriate measures are proposed to be evolved to progressively reduce the dependence of the photovoltaic industry on imports.

International Meetings

18. The Department participated in the Regional Expert Seminar on Solar Photovoltaics technology organised by ESCAP at Bangkok in June 1985. The meeting evolved several recommendations pertaining to regional cooperation, evaluation of PV modules and systems, demonstration activities and production programmes. The Department also agreed to organise a seminar/workshop on Photovoltaics for rural applications within the framework of the South Asian Regional Cooperation.

SOLAR PHOTOVOLTAICS

List of R&D projects supported by the Department
during the year under review
1985-86

<i>TITLE OF THE PROJECT</i>	<i>INSTITUTION</i>
Crystalline and Poly-crystalline Silicon (Material/Device)	
1. Production of Solar Grade Silicon by hot metal Solvent extraction and directional solidification.	RRI, Bhubaneshwar.
2. Studies on Poly-Crystalline Silicon for photovoltaic Solar Energy Conversion-Phase II.	NPL, New Delhi.
3. Electrowinning of High purity, low cost Silicon suitable for Solar Cell Devices.	Anna University, Madras.
4. Polycrystalline Silicon from Rice-Husk	IIT, Kharagpur
Amorphous Silicon Solar Cells	
5. Development of Amorphous Silicon thin film Solar Cells.	IACS, Calcutta.
6. Research, Development and production of Amorphous Silicon Solar Cells.	University of Poona, Pune.
7. Development of Amorphous Silicon Solar Cells.	IIT, New Delhi.
8. Development of techniques for the production, operation and storage of silanes from rice husk for preparing a-si.	IIT, Kharagpur.
9. Production of Silanes for amorphous silicon & Polysilicon applications.	IISc., Bangalore.
10. Amorphous Silicon Solar Cells - Development & Evaluation studies.	IIT, Madras.
11. Investigation on hydrogenated Amorphous Silicon films.	NPL, New Delhi.
Photoelectrochemical Cells	
12. Photoelectrochemical Conversion & storage of Solar Energy	BHU, Varanasi.
13. Photoelectrochemical Solar cells using transition Metal Dechalcogenide Crystals.	Sardar Patel Univ, Vallabh Vidyanagar.
14. Solar Energy Conversion using Narrow Bandgap semiconductor Electrodes in Photoelectrochemical Cells.	Gorakhpur University, Gorakhpur
15. Solar Energy Conversion through photoelectrochemical systems.	IISc., Bangalore

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| 16. Studies in photochemical Conversion of Solar Energy. | MLS University, Udaipur. |
| 17. Energy conversion in Photoelectrochemical systems | IIT, Delhi, |
| 18. Photoelectrochemical Energy Conversion. | IIT, Delhi. |
| Photovoltaic Systems | |
| 19. Development & Demonstration of concentrator photovoltaic Systems. for specific stand alone rural application. | Kalyani University, Kalyani. |
| 20. Photovoltaic Solar Electric Power for Rural Development in Sunderban. | Bidhan Chandra Krishi Vishwa Vidyalaya, Kalyani. |
| Other Projects | |
| 21. Development of thermoelectric generators for Solar (and other) energy conversion-phase II. | IIT, Kharagpur. |
| 22. Study on large Semiconductor liquid junction Photovoltaic Cells. | Shivaji Univ., Kolhapur. |
| 23. Photovoltaic Solar Energy Conversion & Storage ion implantation and laser annealing studies. | IIT, New Delhi. |
| 24. Investigations on ternary semiconductors with possible application as photovoltaic devices. | IIT, Madras. |
| 25. Characterization of Copper-Indium-Di-Selenide and formation of thin film heterojunction Solar Cells : CdS : CuInSE | IACS. Calcutta. |
| 26. Indium-Tin-oxide based interfacial layer Heterojunction Solar Cells-Phase II. | IIT, New Delhi. |
| 27. Development of Nontracking luminescent concentrators for Conversion of Solar Energy. | IIT, Madras. |
| 28. Studies on InP based heterojunction Solar Cells InP/ITO and InP/Cds. | IACS, Calcutta. |
| 29. Study of Ternary chalcopyrite semiconducting films as photovoltaically active materials. | University of Rajasthan, Jaipur. |
| 30. Development and demonstration of solar energy concentrator for Photovoltaic Panels. | IIT, Delhi. |
| 31. Feasibility studies on the development of an organic dye solar cells. | IIT, Delhi. |

Reproduced from the Annual Report 1985-86 of the Department of Non Conventional Energy Sources, Ministry of Energy, Government of India.

UNIVERSITY GRANTS COMMISSION

Bahadur Shah Zafar Marg
NEW DELHI

Awards to outstanding scientists out of the endowment created with the sum received from Hari Om Ashram Trust, Nadiad (Gujarat) for 1985.

The University Grants Commission has instituted the following awards of the value of Rs. 10,000/- each to be given away every year from 1974 onwards to outstanding scientists in the fields indicated against each :

1. The Sir C. V. Raman Award for Experimental Research in Physical Sciences.
2. The Homi J. Bhabha Award for Research in Applied Sciences.
3. The Meghnad Saha Award for Research in Theoretical Sciences.
4. The Sir Jagdish Chandra Bose Award for Research in Life Sciences.
5. Award to outstanding Scientists/Social Scientists in the field of 'Interaction between Science and Society'.

The Awards from S. No. 1 to 5 are subject to the conditions given in *Annexure-I* and the nominations for these awards are invited for the year 1985.

It is requested that the details of the awards may be brought to the notice of outstanding scientists/researchers of your university/institution/organisation. The names of suitable persons (which may not be restricted to person of your university/institution/organisation) alongwith their bio-data may be sent to the Commission for consideration by 30th June 1986. *While sending nominations, the name of the award under which the candidate wants to be considered may be mentioned clearly.* Any person already nominated twice in the last 5 years may not be nominated again. The awards from S. No. 1 to 5, up to year 1982 have been given away and the awards for the year 1983 and 1984 are under consideration of the Commission.

The persons recommended in the preliminary selection will be required to supply the requisite documents in support of their work. The final selection will be made on the recommendation of a Jury to be appointed by the Commission.

Annexure-I

Conditions for Awards from S. No. 1 to 4.

- (i) Only contributions by Indian Scientists/Social Scientists, individual or by a team of 2 to 3 persons would be eligible for this award. The institutions or organisations are not covered under the scheme.
- (ii) The prize would be awarded to an individual or a team for outstanding contributions to the development of interaction between science (including Technology) and society and which has made conspicuously important contribution to the development of Indian Society.
- (iii) In deciding the award attention would be focussed on the specific contributions made during the last five to seven years period.
- (iv) The work to be assessed would cover books, monographs, papers or any other published account of research work, inventions, discoveries etc. which have not already received a similar award from any other agency.
- (v) The work would have been carried out in India.

Conditions for Award at S. No. 5

1. Social, Economic, Cultural and Political factors which have either promoted or impeded development of scientific ideas, their implementation and acceptance and application for the benefit of society.
2. Generation of concepts concerning development of Science, its value system and its impact on the Indian Society from time to time.
3. Development of scientific culture and temper as an integral part of fabric of social structure.
4. Strategies and movement of relevant scientific developments which have made a distinct contribution to the national developments and welfare of society.
5. Contributions through analysis of factors responsible for promotion of scientific and technological development and initiation of appropriate processes of change through active participation.
6. Development of scientific policies and their implementation and the beneficial results accruing from such scientific policies and endeavours.
7. Strategies for scientific development.
8. The words "Science/Scientific" in these guidelines may be interpreted in broad terms to include not only the Natural Sciences – Physical, Biological, Mathematical but also to cover Social Sciences and contributions which have relevance in India.

To our Contributors

Publication Charges : Authors will have to pay Rs. 75/- as publication/reprint charges for one article. This will entitle them to 100 reprints.

Subscription Rates :

(1) Annual Subscription for non-members		
Inland (By Book Post)	Rs.	100.00
Foreign (By Surface Mail)	\$	30.00
(2) Single issue for non-members		
Inland (By Book Post)	Rs.	10.00
Foreign (By Surface Mail)	\$	5.00
(3) Annual Subscription for members (By Book Post)	Rs.	38.00
(4) Extra reprint charges : For every extra 100 reprints or part thereof	Rs.	30.00

Note : Registration and Air Mail Charges Extra

Instructions to Authors :

The Journal publishes short communications containing original research of immediate importance. Papers containing information which break fresh grounds shall be given priority. Routine investigations which report merely experimental observations or routine modifications in theory are not usually accepted. Taxonomical papers will not be published unless on the basis of experiment/observation of a new relationship related to evolution has been established or a new technique has been used in the experiment/observation. In Mathematics such papers will not be published the contents of which are merely exercise to basic theorems or principles. Review papers are not accepted for this journal. Speed of publication is an important feature of this journal.

From the very nature of such publication, it is imperative that the authors are as brief and precise in presenting their work as possible. The following restrictions will be imposed :

- Each communication may not contain more than 1500 words. It should be preceded by an 'Abstract' of not more than 50 words.
- Manuscripts should be typewritten in English, double spaced and should be submitted in duplicate. All mathematical expressions should be typed or written clearly in black ink.
- The communication should contain a minimum number of tables, figures and photographs. Figures must be drawn in such a way that they can be reduced to one column width (7.5cm). Figures must be original drawings or exceptionally sharp glossy prints of about manuscript size. The space occupied by the figures/tables/photographs will be at the expense of text, because no LETTER which occupies a space more than 1500 words space may be published.
- All references should be indicated in the text by superscript arabic numerals, e.g. "Mirri² while working on..". The list of references should be arranged in order of their occurrence in the text. Reference should be given in the following style :

2. MIRRI, M. A. (1982) *J. Chem. Phys.* 58 : 282. (For articles in Journals).

Author year Journal vol. beginning page

White, M. J. D. (1973) *Animal Cytology and Evolution*, 3rd Ed., Cambridge University Press, London, p. 320 (For Books).

Osgood, C. F. (1977) in *Number Theory and Algebra*, ed. Zassenhaus, H., Academic Press, New York, p. 321. (For edited Books)

Abbreviations of the names of periodicals should conform to those given in the World List of Scientific Periodicals.

- Key words : A maximum of 5 key words should be supplied. Each of these words will be separated by a slash (/) and printed just below the title of the research paper, e.g. (steroid receptors/protein-DNA interactions/gene regulation).
- Acknowledgements, if any, should appear at the end of the letter, but just before the references.
- Proofs will not ordinarily be sent to authors. If more than 100 reprints are needed, indicate the extra number while sending the manuscript.

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